論文 / 著書情報
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
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Doctoral Program

論 文 要 旨

THESIS SUMMARY

系・コース： Department of, Graduate major in	Materials Science and Engineering 系 コース	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of （Philosophy）
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要旨（英文 800 語程度）

Thesis Summary（approx.800 English Words ）

This thesis is entitled "Fiber Structure Formation through Single- and Bi-component High-speed Melt Spinning and Subsequent Annealing of Poly(L-lactide) and Poly(D-lactide)" and consists of seven chapters.

In Chapter 1, "General Introduction", fundamental characteristics of the bio-based polylactide (PLA) for the production of man-made fibers is given, and the variety of molecular structures, i.e. poly(L-lactide) (PLLA), poly(D-lactide) (PDLA) and racemate PLA, and the variety of crystalline structures, i.e. homo-crystals and stereo-complex (SC) crystals influencing the basic properties of PLA fibers were introduced.

In Chapter 2, "High-speed melt spinning of single component and core-sheath bicomponent fibers of high optical purity poly(L-lactide)s with different molecular weight", low and high molecular weight (Mw) PLLAs with the optical purity higher than 99.5% were used for the preparation of fibers through the single and bicomponent high-speed melt spinning process. Thinning behavior of the spin-line was observed during high-speed spinning process to investigate the crystallization behavior. The core-sheath (C/S) bicomponent PLLA fibers consisting of different Mw showed distinctive properties compared with respective single-component fibers through the mutual kinematic interaction of the two components in the spin-line. Especially at high take-up velocities, the high Mw component exhibited highly oriented and crystallized structure whereas the orientation and crystallization of the low Mw component was significantly suppressed because of the orientation relaxation after the crystallization of the high Mw component in the spin-line.

In Chapter 3, "High-speed melt spinning of single component and core-sheath bicomponent fibers of poly(L-lactide)s with different D-lactide content", C/S PLLA fibers were produced through the bicomponent high-speed melt spinning process using the PLLAs of the same melt flow rate but unequal D-lactide contents, i.e. PLLAs with optical purities of >99.5% and 96%. Structure development of individual components in bicomponent fibers proceeded differently in comparison with their single-component spinnings, in that the structure development of the PLLA(>99.5%) was enhanced while that of the PLLA(96%) was significantly suppressed. The promotion and suppression was more significant when the PLLA(>99.5%) was used as the sheath component.

In Chapter 4, "Crystalline formation in high-speed melt spinning and subsequent annealing of racemic polylactides", preparation of racemic PLA fibers was carried out using the 50:50 compound of PLLA and PDLA premixed using the PLLA of different Mw. Single component spinning of the compound with lower Mw PLLA was not possible because of thermal degradation in the compounding process while that of the compound with higher Mw PLLA could be accomplished even though spinnability was limited. The C/S fibers were also prepared using the PLLA with high optical purity as the sheath component and the compound of low Mw PLLA and PDLA as the core component. All as-spun fibers were mainly consisted of homo-crystals after the starting of orientation-induced crystallization at high spinning speeds. Improvement of the crystalline structure of as-spun fibers was attempted through the annealing at 120 and 190 °C, the temperatures lower and higher than the melting temperature of homo-crystals. For the C/S fibers, annealing at 120 °C was possible and the fibers consisting of un-oriented SC-crystal and high amount of oriented homo-crystal could be produced. The fibers prepared at 4 and 5 km/min using the compound of higher Mw PLLA and PDLA could be annealed at 190 °C, and the formation of fibers consisting of high amount of highly oriented SC-crystal could be achieved.

In Chapter 5, "Development of polylactide fibers consisting of highly oriented stereo-complex crystals utilizing high-speed bicomponent melt spinning process", bicomponent high-speed melt spinning of islands-in-the-sea (I/S) fibers consisting of PDLA and PLLA as the island and the sea components, respectively, was performed. The fibers containing large number (1519) of islands could be produced successfully. For comparison, C/S fibers consisting of PDLA core and PLLA sheath were also prepared. Post annealing of the as-spun fibers at temperatures of 120 and 190 °C revealed that the fiber shape could be maintained after the annealing of high-speed spun I/S fibers at 190 °C for 1 hour, and the fibers consisting of a large amount highly oriented SC crystals could be prepared. This result suggested that the size of the cross-sectional configuration of the I/S fiber was small enough for the effective mutual diffusion of PLLA and PDLA molecules in the fiber cross section.

In Chapter 6, "In-situ measurement of crystalline structure variation during heat-treatment of high-speed melt spun bicomponent fibers consisting of poly(L-lactide) and poly(D-lactide)", unoriented and oriented I/S fibers prepared at the take-up velocities of 1 and 6 km/min were subjected to the annealing processes of various conditions, i.e. heating rates of 5 and 50 °C/min, holding temperatures of 190, 200 and 210 °C, and the cooling rate of 5 °C/min. In-situ measurement of the crystalline structure formation was carried out applying the wide-angle X-ray diffraction technique. Variations of the relative contents of homo and SC crystals and amorphous phase were estimated. Formation of homo crystals was promoted under lower heating rate. The SC crystals started to appear during the heating process, whereas the increase of its amount was limited during the annealing process. On the other hand, increase in the melting temperature of homo-crystals with the co-existence of the SC crystals was confirmed. Strong memory effect was also recognized for the formation of homo crystals during the cooling process.

In Chapter 7, "General Conclusions", results obtained in this research was briefly summarized and the problems which need to be solved in the future were discussed.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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